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A MANAGEMENT PLAN TO DEAL WITH
CONTAMINATED FILL ON THE LAX
PROPERTY

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**A MANAGEMENT PLAN TO DEAL WITH
CONTAMINATED FILL ON THE LAX PROPERTY**

Prepared for

The City Architect's Department

The City of Hamilton

by

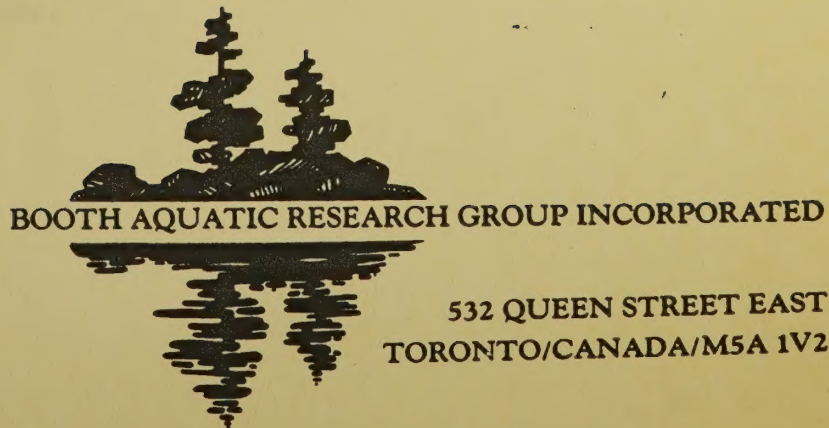
Booth Aquatic Research Group Inc.

March 1986

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GOVERNMENT DOCUMENTS



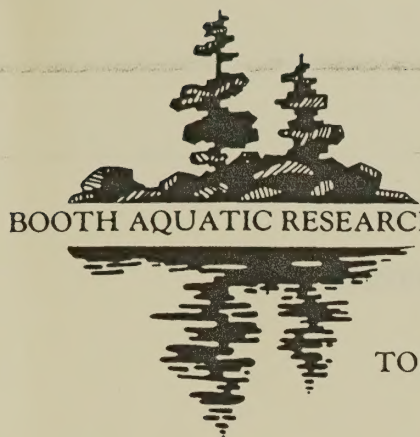
A MANAGEMENT PLAN TO DEAL WITH CONTAMINATED
FILL ON THE FORMER LAX PROPERTY
MARCH 1986 BOOTH AQUATIC RESEARCH GROUP INC.

The following revisions/clarifications were suggested by the City Architect's Department:

1. Title All References should read "Former Lax Property"
2. Page 2 third paragraph - "The Forde report...recommended... wind erosion (TABLE 2)

- delete recommended and replace with "suggested various alternative remedies including covering, burying deeper or removal."
3. Page 4 Last paragraph - "They do not appear on the northern arms of the site".- delete as superfluous.
4. Page 5 First paragraph reference to "(Vogt, pers. comm.)" should be verified and clearly identified (i.e. John Vogt, Hamilton-Wentworth District Officer, Ministry of the Environment.)
5. Page 5 Fourth paragraph - "Further investigation...at the present time...surface run-off". "At the present time" should be clarified in the context of when, if ever, a problem with the run-off could occur, eg. during implementation of the Master Plan and the creation of the islands etc.
6. Page 5 Last paragraph - "Levels of Cd, Zn...Windermere Basin by Envirosearch (1985). Windermere sediments". Unclear why comparison is made to Windermere Basin.
7. Page 7 Second paragraph - "In summary....at the present time." Clarify "at the present time".
8. Page 9 Disposal Options - Options for both Hazardous and Non-Hazardous Waste Disposal should be accompanied with cost estimates.
9. Page 10 Step 4 - Should be deleted as a step in the process of the management plan since it is really part of the implementation of the Master Plan and not a result of the contaminated fill on the former Lax lands.

1986 April 2



BOOTH AQUATIC RESEARCH GROUP INCORPORATED

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(416) 362-2457

March 26, 1986

Mr. David Freeman
City Architect
The City of Hamilton
Hamilton City Hall
71 Main Street West, 4th Floor
Hamilton, Ontario
L8N 3T4

Dear Mr. Freeman:

We are pleased to present you with the draft report: A Management Plan to deal with Contaminated Fill on the Lax Property.

This report summarizes our investigations into the environmental significance of contaminated fill discovered on the Lax Property. We have made recommendations based on these investigations and consultations with the Ministry of the Environment.

Would you please review the draft report and forward your comments to us, so that we may incorporate them into the final report.

Sincerely,
BOOTH AQUATIC RESEARCH

David A. Ross

Enc.
DAR/rs

DRAFT

A MANAGEMENT PLAN TO DEAL WITH
CONTAMINATED FILL ON THE LAX PROPERTY

Prepared for

The City Architect's Department

The City of Hamilton

by 

Booth Aquatic Research Group Inc.

David A. Ross

March 1986

DRAFT

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LAX PROPERTY ENVIRONMENTAL MANAGEMENT

Executive Summary

The report summarizes data from several sources which delineate the problem of pockets of industrial waste which have been deposited on the Lax Property. The analysis of groundwater leaching through the site showed that currently the groundwater meets drinking water guidelines set by the Ministry of the Environment.

Sampling of nearshore sediments adjacent to the site shows one major area of contamination to the south of the Property in the vicinity of a combined storm sewer/sewage overflow in an isolated bay between the CN railyard and the Lax Property. Other areas have some minor contamination problems. Water quality around the perimeter of the site does not appear to be adversely affected by the contamination within the Property. There was evidence of zinc contamination in water samples taken over the contaminated sediments in the bay to the south of the Property. This water is most likely contaminated by the sediments in the bay, but may be partly due to the waste material in the Property.

The problems associated with the contaminated waste in the Lax Property do not currently present a major environmental risk. There is, however, the potential for future increased concentrations of metals in the leachate. Currently there are concentrated pockets of industrial waste which are clearly visible due to the lack of any covering vegetation and in some instances their black colour. These exposed areas present a danger from wind erosion and to anyone using the site.

The recommendations are to excavate all visible surface pockets of contamination down to 2 m and to cap these sites with the clay fill currently stockpiled on the site for this purpose. The excavated material should then be removed from the site and disposed of by a licensed waste disposal facility.

A monitoring program is recommended to test the groundwater leaching through the site at 2 month intervals up to the time when implementation of the Waterfront Master Plan begins or for two years. If the metal levels in the groundwater increase substantially, then the recommendations include capping the entire site with clay fill to reduce percolation from surface precipitation and/or installing a tile drainage system in conjunction with the proposed development.

The recommended program will reduce the potential for contaminated water leaching into the Harbour, will eliminate the chance of wind

erosion of the surface waste, will ensure that users of the site are not exposed to contaminated soil and will provide a conservative, environmentally and socially acceptable approach to dealing with the problem.

Introduction and Background

The City of Hamilton acquired the Lax Property in November, 1984. Surface soil sampling by the Ministry of the Environment (MOE) Phytotoxicology Section indicated that isolated areas contained small quantities of industrial contaminants which had been used as fill in the construction of the property (Table 1). They recommended that some of this fill be removed from the property, based on potential phytotoxicity, toxicity to grazing animals and human health considerations (Palmer 1985).

The City immediately arranged for further investigation into the extent of contamination in the property. A series of 16 boreholes were drilled by McGlone & Associates and visual descriptions of the contents were prepared (McGlone 1985). Four of the soil sampling boreholes were prepared as piezometers to monitor the possible contamination of groundwater in the property. The Regional Laboratories of the Municipality of Hamilton-Wentworth carried out analysis for trace metals on the cores and measured concentrations of metal contaminants in the groundwater (Forde 1985). The Forde report identified small pockets of industrial wastes on the property and recommended that those areas be covered with clean soil to prevent wind erosion (Table 2). They concluded that the groundwater was not significantly contaminated and would not adversely affect the harbour waters (Table 3) (Forde 1985).

The MOE Hamilton Region also implemented groundwater monitoring during the summer of 1985 using the same four piezometers as Forde (Mayes 1985). Analysis yielded similar results to those found by Forde (1985) (Table 3).

Booth Aquatic Research Group Inc. (BAR) was retained by the City of Hamilton to develop a management plan for the removal and/or containment of these pockets of industrial waste products in the Lax Property. Consultations with the Hamilton Region MOE office, Regional Laboratories and consulting engineers were incorporated into the development of this plan.

Methods

All data from previously mentioned sources were reviewed and utilized to determine the impact of the contaminated fill on the environment and to facilitate the development of a management plan. Further consultations with Hamilton Region MOE raised the concern of the possible effect the contaminated fill was having on

the nearshore sediment and water quality in Hamilton Harbour. A methodology was formulated to address this concern and, upon approval by the MOE, was implemented.

Nine stations were selected around the perimeter of the Lax Property in which to sample sediments and water. Station selection was based on proximity to contaminated fill, observed drainage patterns and to allow for adequate representation of variability around the site (Figure 3). On December 18, 1985, water samples were collected at each station from the nearshore area (0-0.5 m depth). Surface samples were collected from each of 4 control sites in the Harbour to establish background conditions in the Harbour at the time of sampling. Water samples were analyzed for parameters identified in previous studies as being present in excessive concentrations in the landfill. All samples were preserved with nitric acid and submitted to the Regional Laboratories of Hamilton-Wentworth for analysis of the concentrations of cadmium (Cd), copper (Cu), nickel (Ni), lead (Pb), zinc (Zn), manganese (Mn) and chromium (Cr). A field pH was measured on all water samples using a Cole-Parmer Digisense meter within 6 hours of the collection.

Two to four sediment samples were collected from each station at 0, 5, 10 and 20 m offshore along a transect set perpendicular to the shore. A Ponar dredge was used to collect the top 10 cm of sediment in these locations. Samples which appeared to be contaminated by industrial waste were submitted for analysis. The remaining samples from each transect were stored in refrigerators at the Regional Laboratories. Data recorded at the time of sampling included station depth, distance from shore, sample composition, colour, cohesiveness and texture.

Sediment samples were analyzed for Cd, Cu, Ni, Pb, Zn, Mn, Cr and loss on ignition (LOI) at the Regional Laboratories and for PCBs and oil and grease at Zenon Environmental Ltd.

Results are tabulated in Tables 4 and 5.

Results

Reports referenced in the introduction can be reviewed for a detailed description of the sampling results obtained by their authors. The chemical sampling results have been summarized here in Tables 1 (Palmer), 2, (Forde) and 3 (Mayes). The results of the December 1985 sampling by BAR are as follows.

Nearshore Sediment:

Samples from the nearshore perimeter of the Lax Property which appeared to consist of industrial products were submitted for

analysis. Results indicated that the sediment quality found at Stations 4-9 (Figure 3) was better in all cases than the mean for Hamilton Harbour sediments found by the MOE in 1980 (MOE 1985). Trace metals, organic content (LOI) and PCBs were present only in small quantities at these stations (Table 5).

Stations 1-3 (Figure 3), all at the southeast end of the bay separating the Lax Property from the CN tracks, exhibit concentrations of all parameters measured, except Mn, at greater levels than the 1980 Hamilton Harbour mean (Table 5) (MOE 1985).

Stations 1A and 3A had the greatest concentrations of Cd at 16 mg/kg and 10 mg/kg respectively (Table 5), greater than the 5.7 mg/kg found by the MOE in 1980 for mean results in Hamilton Harbour (MOE 1985). Sediment Cu concentration of 340 mg/kg at Station 2B next to the storm sewer outlet was about 2.5 times the 1980 mean for Hamilton Harbour. Lead concentrations were as high as 945 mg/kg at Station 1A and Ni as high as 400 mg/kg at Station 2B (Table 1). Total PCB concentrations ranged from 0.22 to 0.82 mg/kg at Stations 1-3, compared to a median of 0.200 mg/kg for harbour sediments found by the MOE in 1980 (MOE 1985). Oil and grease concentration ranged from 6,500 to 17,000 mg/kg at Stations 1-3 (Table 1).

Water Quality:

Concentrations of trace metals in the nearshore water (Table 6) did not differ substantially from concentrations measured at control Stations 10-13 (Figure 1) or with MOE results for harbour means (MOE 1985).

The exceptions were Stations 1, 8 and 9. Station 1 had a measured concentration of Zn of 0.35 mg/L, almost 10 times the control concentrations (Table 6). Stations 1 and 8 had a measured total Mn concentration well above the control sites. Station 9 nearshore water quality showed a Zn concentration of 0.11 mg/L, greater than the control sites and measurements of harbour mean Zn of 0.046 mg/L (MOE 1985).

Discussion

Studies referenced in the introduction revealed that some small surface areas of the Lax Property were contaminated with industrial waste products and are clearly visible and lacking vegetative cover. They do not appear on the northern arms of the site. Vertical bore hole sampling by Forde (1985) revealed additional small pockets of industrially contaminated fill to be distributed vertically and horizontally through the central area of the property. Characterization of the contaminated fill by Forde (1985) (Table 2) and Palmer (1985) (Table 1) indicated high

concentrations of Zn, Pb and Cd in some samples. Elevated levels of Cu and Cr were also noted. Visual inspection and tracing of the origin of the fill verified that about 500 tonnes of Burlington Steel flue dust was deposited on the property (Vogt, pers. comm.).

Analysis of steel flue dust by Kramer and Murdoch (1985) indicated that the majority of trace metals are associated with strongly bound insoluble silicates and ferrites, although Mn seemed to be quite soluble as a hydroxochloride. Dissolution of fine-grained metallic alloys and oxides by weakly acid solutions seems to mobilize some significant amounts of Cu, Cd, Pb and Zn. Measurements of pH of groundwater in the Lax Property by Mayes (1985) and Forde (1985) revealed a range of pH 7-8. Under these conditions the majority of metal elements would remain fairly insoluble and should not threaten groundwater or harbour water quality.

However, slightly elevated concentrations of some metals were measured in the groundwater by Mayes (1985) and Forde (1985), indicating that some fraction of the total trace metals may be soluble and entering groundwaters (Table 3). Trace amounts of PCBs were also found by Mayes in some groundwaters. Some small pockets of contaminated fill discovered by Forde (1985) are below water table levels described by Trow (1984) and McGlone (1985). In addition, rainwater percolation may be leaching additional small quantities of contaminants from the surface pockets of industrial fill into the groundwater.

Further investigations by BAR indicate that at the present time there does not appear to be any major problem of industrially contaminated fill polluting the harbour waters by groundwater or surface runoff. Nearshore water and sediment quality did not differ substantially from control stations (Tables 5 and 6) except at Stations 1-3. Nearshore sediments were somewhat more sandy than offshore sediments and contained lower concentrations of contaminants (BAR 1986).

Nearshore sediment at Stations 1-3 was contaminated with trace metals and PCBs at concentrations which exceed Hamilton Harbour means (MOE 1985) and exceeded other samples taken from areas of proposed dredging offshore of the Lax Property (BAR 1986). The close proximity of a storm sewer/combined sewage overflow is the most likely cause of this contamination. Construction of the property restricted the discharge of the storm sewer to the back end of a narrow bay (Figure 1) which receives little flushing. Levels of Cd, Zn, Pb and Mn in this isolated bay were of similar concentrations to those found in surficial sediments of Windermere Basin by Envirosearch (1985). Cr, Cu, Ni and PCB concentrations were considerably lower than Windermere sediments.

The high concentrations of total metals found in sediments at Stations 1-3 were not significantly affecting local water quality, although concentrations of Zn, Cu and Cr found in nearshore water did exceed the MOE guidelines for protection of aquatic life (MOE 1984). These guidelines provide a good, long-term objective for the harbour, but a more realistic comparison is with present harbour values to ensure that the Lax Property does not adversely affect harbour waters or sediment.

Zn concentrations in water sampled at Station 1A exceeded the control stations by 10 times (Table 1). At a hardness of about 200 mg CaCO_3/L in Hamilton Harbour and pH of 7, the 0.35 mg/L of total Zn measured at Station 1 would not be acutely lethal to rainbow trout (Bradley and Sprague 1985) although sublethal effects cannot be ruled out. Stormwater runoff can load substantial amounts of Zn to a water body, but in the case of Hamilton Harbour less than 1% of total Zn inputs in 1977 were the result of stormwater (MOE 1985). Poor water quality at this site may, however, be related to the contaminated sediments.

Although the storm sewer is likely the major source of contaminants to this area, the role of nearby contaminated fill cannot be ruled out completely. Adjacent railyards may also be contributing contaminants to this area.

Mn was also found at an elevated concentration in water samples from Stations 1A and 8 (Figure 3). Palmer (1985) identified his site 12 (Figure 1) as having very high concentration of Mn present in surface soil samples collected. Steel flue dust is thought to contain fairly soluble Mn (Kramer and Murdoch 1985) and surface runoff may be introducing Mn to the harbour in this area. No MOE guidelines are available regarding acceptable levels of Mn for drinking water or the protection of aquatic life.

Contaminated water and sediments found at Stations 1, 2 and 3 could eventually lead to increased body burdens of persistent compounds in harbour fishes. Fish can accumulate contaminants from their water and their food. Bottom dwelling invertebrates such as oligochaete worms have been found to concentrate substantial amounts of persistent chlorinated organics such as PCBs (Oliver 1984). Bioaccumulation can eventually produce concentrations in fish tissue that are dangerous to top level consumers. At present most fish species sampled in Hamilton Harbour by the MOE can be eaten in unlimited quantities, with some restrictions imposed on larger size classes of carp, white perch and brown bullhead (MOE 1985).

* Special consideration will have to be given to the sediments in this location.

The removal of these sediments will be incorporated into the dredgeate disposal plan for the waterfront development.

In summary, the small amounts of contaminated fill found on the property are not adversely affecting Hamilton Harbour at the present time. The following management plan has been suggested in order to minimize the potential risk of future harbour contamination resulting from surface runoff and rainwater percolation leaching surface contaminants into the groundwater. The small pockets of contaminated fill located deeper in the property are not adversely affecting groundwaters at present, but the following plan will address future concerns.

RECOMMENDED ENVIRONMENTAL MANAGEMENT OF THE LAX PROPERTY

STEP 1: Program for removal of surface areas of contaminated soils

The program outlined below will effectively remove the majority of the contaminated fill, except for some isolated deeper pockets. Removal of the surface material will effectively eliminate the mobilization of surface contaminants by wind erosion, surface runoff and rainwater percolation.

Although these areas of contaminated soils do not appear to be currently adversely affecting the groundwaters or Hamilton Harbour, they are not able to support plant growth and are a concern to the public. Removal will satisfy the public's concern as well as ensuring a safe environment for future use of the site.

(a) Delineate areas to be removed

In the spring of 1986, the areas which are to be removed should be delineated by fencing and numbered for reference. Selection of sites requiring removal should be based on sampling to date and visual inspection.

(b) Determine if waste is non-hazardous or hazardous

To determine the appropriate disposal option for these surface areas, a surface sample of soil should be analyzed from each delineated area. An acid-leach test will determine if the material is hazardous or non-hazardous. If non-hazardous, a distilled water leach test will determine which landfill site can accept it.

(c) Excavate the contaminated material

The contaminated surface material should be excavated by the City. The depth may vary depending on visual inspection during the operation. An industrial waste expert should be provided by the City (through Regional Laboratories) to oversee the excavation. The Ministry of the Environment Industrial Waste Abatement Section should be notified so that they can inspect the procedure.

(d) Dispose of the contaminated material at the appropriate disposal site

The City should tender a contract to the appropriate disposal facilities for removal and disposal of the excavated material. The acid-leach tests done in (b) will determine whether the waste is hazardous: if so then either Tricil or Phillips Enterprises can dispose of the waste. If the waste is not hazardous, then a

distilled water leach test will determine which non-harzarious waste sites can accept the material.

The City should specify that trucks entering the site to remove the waste are washed down prior to leaving the site so as not to track contaminated material through City streets. They should also require appropriate liability and damages insurance from the disposal service.

Disposal Options

Harzarous Waste Disposal:

If an acid-leach test determines that the waste is hazardous, then the options are:

Option 1: Tricil Ltd., R.R. #1, Telfer Sideroad, Corunna, Ontario, N0N 1G0. Tel: (519) 864-1021

- Can provide transportation and disposal of hazardous waste

Option 2: Phillips Enterprises, 52 Imperial Street, P.O. Box 423, Station B, Hamilton, Ontario, L8L 7W2. Tel: 544-6687

- Can provide a service to stabilize the waste on site, or at their facilities. The process renders the waste non-hazardous so that it can be disposed of at a non-hazardous waste disposal site. Verification of the process on a representative sample is recommended prior to selecting this option.

Non-Hazardous Waste Disposal:

Once the material has been classified as non-hazardous, a distilled water leach test will determine which waste disposal sites can accept the waste.

Option 1: Steetly, 447 Moxley Road South, R.R. #2, Dundas, Ontario, L8H 5E2. Tel: 672-3551

- Can accept waste where distilled water leachate does not exceed twice the MOE Irrigation Standards.

Option 2: Taro Aggregates, 341 First Road West, Hamilton, Ontario, L8S 1W4. Tel: 561-0303

- Can accept waste were the distilled water leachate does not exceed twice the MOE Drinking Water Standards.

STEP 2: Fill excavated areas with clean fill to prevent further mobilization

Clean fill which is currently stockpiled on the Lax Property is high in clay content and will make good covering fill. The fill on these areas will make a relatively impermeable cap which will prevent exposure of freshly uncovered soils to wind and water erosion and will restrict percolation of precipitation through deeper soil.

STEP 3: Monitor groundwater quality to determine whether there is any future deterioration

The present level of contaminants in the property groundwaters are acceptable. However, assurances must be provided that it will not deteriorate in the near future.

Monitoring of the groundwater in piezometers already in place, up to the implementation of the proposed Master Plan development or a maximum of two years, will quantify any deterioration from present acceptable levels. Sampling every two months should accomplish this.

If the groundwater quality significantly deteriorates, then consideration should be given to capping the entire property with clay. This will effectively minimize further contamination of groundwater by reducing rainwater percolation through the property which may be leaching contaminants into the groundwater.

Capping could be done alone or in conjunction with landscaping as proposed in the Waterfront Master Plan. An alternative option to capping may be to install a surface tile drainage system to capture surface runoff and minimize rain percolation into the property. The tile system could drain into the site's sewage system if the collected water quality was unacceptable as stormwater to the harbour.

STEP 4: Remove contaminated sediments found near Stations 1, 2 and 3 as part of the implementation of the proposed Master Plan

Sediments at Stations 1-3 were found to be significantly contaminated with metals, oil and grease. During the removal of the neck of the property to create an island, these sediments will have to be removed. Careful removal using silt screens will reduce the potential for distributing these contaminated sediments to other areas of the harbour. Disposal of the sediments and appropriate measures to mitigate hazards during their removal will be incorporated into the plan to manage dredge disposal.

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Palmer, K.T. 1985. Preliminary survey of waste materials deposited at the proposed park site, Hamilton Harbour, November, 1984. Ministry of the Environment, ARB No. ARB-050-85-PHYTO.

Trow Ltd. 1984. Foundation and related geotechnical investigations, Lax Property, Hamilton Harbourfront.

Table 1 Concentrations(dry weight) of 16 elements,conductivity, and pH in soil samples(0-15 cm depth) collected from 13 stations at the City of Hamilton proposed park site on November 29,1984. Due to the high concentration of many of elements,the values given are approximate. Station 5 is a control. See Figure for station locations. Results in ppm. unless otherwise noted. From Palmer,1985.

Station	Al	An	As	Bo	Cd	Ca	Cr	Cu	Fe	Pb	Mn	Mo	Ni	Se	Vn	Zn	Cond.	pH
mg/kg																		
%																		
1	25.0	13.0	3.9	690	28	0.9	220	7200	1.3	1800	2000	14	130	4	44	14000	4.0	7.1
2	1.0	63.0	96	12000	600	3.5	2300	2200	22	23000	45000	500	1000	3	1000	280000	1.2	8.8
3	0.4	41.0	92	8200	450	3.6	2800	2400	31	19000	57000	250	290	2	200	180000	0.3	8.5
4	0.9	3.0	9.7	3600	16	4	120	110	3.3	2000	3100	10	42	0.4	31	7700	0.3	7.7
5	1.0	11.0	5.5	12	1	4.7	16	43	2	48	690	1	16	0.2	23	140	0.3	7.7
6	1.9	0.5	8.7	34	1.3	3.6	27	13	3.4	19	690	1	28	0.4	29	100	0.1	7.9
7	0.5	0.5	1.7	21	1.0	1.3	170	43	1.1	50	1400	18	250	1.9	11	280	0.1	7.9
8	1.0	1.4	6.8	17	1.4	2.2	20	55	2.2	370	830	1	16	0.6	26	250	0.2	7.8
9	2.1	1.3	1.4	46	1.5	3	29	12	3.8	29	740	2	29	0.5	33	91	0.1	8
10	0.1	0.2	1.4	10	0.6	0.6	600	19	2.4	21	190	57	2500	0.5	9	90	0.1	8.4
11	1.6	12	15	3300	140	2.8	310	470	7.7	7100	10000	100	230	1.6	200	69000	0.2	8.1
12	1.0	69	87	15000	760	3.9	1800	1900	19	20000	36000	500	1000	4.3	1000	320000	0.4	8.2
13	0.5	24	90	3800	250	6.4	2300	1400	31	16000	47000	92	200	0.6	100	82000	0.3	8.4
MOE Proposed																		
Clean-Up	-	-	25	-	4	-	1000	300	-	500	-	5	200	5	-	800	-	-

Table 2 Analysis of borehole samples from the Lax Property, by Hamilton-Wentworth Regional Laboratories, August, 1985. Results in $\mu\text{g/kg}$ dry weight unless noted. From Forde, 1985.

Station depth(m)	Al Z	Cd	Cr	Cu	Fe Z	Mn	Ni	Pb	Zn
1-1	0.43	155.0	1012.5	970.0	11.30	24250.0	117.0	20375.0	41000.0
1-2	0.82	2.5	115.0	95.0	1.80	1262.5	26.5	712.0	1350.0
1-6	1.09	3.0	75.0	32.0	1.70	887.5	26.0	95.0	800.0
2-4	0.86	3.0	99.0	41.0	1.50	675.0	27.0	82.0	400.0
2-6	0.95	4.0	1475.5	190.0	8.00	1425.0	91.5	133.5	750.0
3-2	0.80	2.5	97.5	29.5	1.30	587.5	23.5	65.0	125.0
3-8	0.25	2.0	275.0	32.0	1.60	2775.0	29.0	92.5	150.0
3-10	0.66	2.5	143.0	57.0	3.00	3862.5	36.0	69.0	650.0
3-11	0.75	3.5	850.0	62.0	7.10	25000.0	43.5	337.5	350.0
4-1	0.99	3.0	90.0	42.5	3.20	1437.5	22.0	103.0	950.0
4-4	0.77	2.5	58.0	29.0	1.90	750.0	19.5	5.5	150.0
5-2	0.47	5.0	74.0	34.5	1.52	1037.5	13.0	325.0	2225.0
5-6	0.76	3.5	79.0	64.0	2.70	825.0	23.0	121.5	620.0
6-1	0.70	7.0	71.0	42.0	2.50	950.0	22.0	400.0	2000.0
6-2	0.76	10.0	86.0	41.0	2.70	1012.5	23.5	600.0	2975.0
7-1	0.88	6.0	129.5	43.0	2.70	837.5	28.5	450.0	2150.0
7-7	1.04	3.0	75.5	26.0	2.90	860.0	26.0	40.0	200.0
8-1	0.46	1.5	74.5	40.0	1.40	887.5	12.5	93.0	525.0
8-5	0.97	1.0	56.0	16.0	3.20	600.0	30.0	68.0	375.0
8-7	0.33	1.5	119.5	11.5	0.90	525.0	11.0	28.5	125.0
9-1	0.69	2.0	96.5	28.0	1.54	1062.5	20.0	156.0	475.0
9-2	1.22	3.0	475.0	110.0	1.95	10000.0	437.5	850.0	825.0
9-4	0.63	1.0	62.0	70.5	7.70	2920.0	34.0	262.5	225.0
10-1	0.35	1.0	56.5	29.5	1.24	860.0	12.0	97.5	350.0
10-5	1.24	2.5	237.5	120.5	1.80	7500.0	25.5	700.0	620.0
11-1	0.68	2.0	66.0	30.0	1.76	775.0	21.0	95.0	500.0
11-2	0.42	2.5	69.0	23.5	1.34	1025.0	16.5	300.0	675.0
11-3	0.41	1.5	122.5	125.0	7.60	1287.5	48.0	98.0	275.0
11-4	0.23	4.5	43.5	153.0	19.70	600.0	21.0	187.5	450.0
12-8	0.40	1.5	41.5	18.0	1.19	387.5	18.0	68.0	212.5
13-1	0.39	2.5	41.5	33.0	1.49	800.0	12.0	162.5	537.5
13-4	0.57	9.0	70.0	99.5	1.73	1537.5	16.5	787.5	3637.5
13-5	0.46	3.5	128.5	86.0	4.30	2337.5	37.5	397.5	400.0
13-7	0.50	1.5	65.0	32.0	1.84	622.5	19.5	71.0	162.5
14-1	0.46	7.0	133.5	45.0	0.99	737.5	16.5	600.0	2525.0
14-2	0.49	5.5	120.5	36.0	1.78	987.5	19.5	625.0	1700.0
15-1	1.10	4.5	225.0	42.0	1.00	160.0	17.0	297.5	700.0
16-1	0.51	7.5	111.5	56.0	1.85	1625.0	18.0	787.5	2650.0
16-2	0.56	4.0	151.0	54.5	1.77	1075.0	28.0	312.5	600.0

Table 3. Analysis of groundwater from the Lax Property by the MOE(Mayes,1995) and Hamilton-Wentworth Regional Laboratories(Forde,1985). See Figure 2 for station locations. Results in µg/l.

Sampler	Station	Fe	Mn	Al	Cu	Cd	Cr	Cu	Ni	Pb	Zn	PCB
Mayes July,1985	2	1.700	2.400	1.500	-	<0.002	0.035	0.058	0.012	0.093	0.560	-
	3	1.600	0.600	0.860	-	<0.002	0.035	0.063	0.014	0.034	0.370	0.00002
	4	2.300	8.600	1.800	-	<0.002	0.050	0.160	0.014	0.052	0.300	0.00002
	11	1.700	2.700	0.670	-	0.010	0.033	0.047	0.014	0.150	3.700	0.00008
	13	4.200	2.300	2.200	-	0.013	0.040	0.440	0.034	0.890	5.800	
Mayes Aug,1985	2	-	9.900	1.400	<0.002	<0.002	0.073	0.074	0.024	<0.030	0.250	
	3	1.650	13.000	0.860	0.114	<0.002	0.073	0.074	0.026	<0.030	0.190	-
	4	0.100	15.000	2.100	-	0.014	0.090	0.110	0.048	<0.030	6.200	-
	13	<0.060	1.900	0.340	<0.001	0.006	0.020	0.044	0.015	0.040	1.800	-
Forde Aug,1985	2	-	2.53	-	-	<0.01	0.17	0	<0.1	0	0.03	-
	3	-	0.30	-	-	<0.01	0.16	0	0	0	<0.01	-
	4	-	0.94	-	-	<0.01	0.75	<0.01	0	<0.01	0.2	-
	13	-	1.29	-	-	<0.01	0.26	0.02	0	0	0.42	-

< : indicates concentration near detection limit; actual value may be less than this

Table 4 Physical description of sediment samples collected from the Lax Property nearshore areas, by Booth Aquatic Research, December 17, 1985.

Station	Water depth (m)	Distance from shore (m)	Composition (%)	Color	Cohesiveness	Texture
1A	0.3	2	100% silt	black	high	greasy&oily
1B	1.0	5	100% silt	black	high	greasy&oily
1C	2.0	10	100% silt	black	high	greasy&oily
1D	2.0	20	100% silt	black	high	greasy&oily
2A	0.5	1	100% silt	black	high	greasy&oily
2B	1.0	5	100% silt	black	high	greasy&oily
2C	1.0	10	100% silt	black	high	greasy&oily
2D	2.0	20	100% silt	black	high	greasy&oily
3A	2.0	5	100% silt	black	moderate	greasy&oily
3B	2.0	10	100% silt	black	moderate	greasy&oily
4A	1.0	1	80% sand 20% silt	grey-brown	low	gritty
4B	2.0	5	50% sand 50% silt	grey	low	greasy
4C	2.0	20	80% silt 20% sand	black-grey	low	greasy
5A	1.0	5	80% sand 20% silt	brown	low	gritty
5B	1.0	10	60% sand 40% silt	grey-brown	low	gritty
5C	1.0	20	60% sand 40% silt	grey	low	gritty
6A	1.0	5	60% sand 40% silt	grey-brown	low	gritty
6B	3.0	10	100% silt	grey	moderate	gritty
6C	4.0	20	100% silt	black-grey	moderate	gritty
7A	1.0	5	60% sand 40% silt	brown	low	gritty
7B	2.0	10	80% silt 20% sand	grey-brown	moderate	-
7C	4.0	20	90% silt 10% sand	black-grey	moderate	-
8A	0.5	3	60% clay 40% silt	grey-brown	high	greasy
8B	1.0	6	90% silt 10% sand	black-grey	moderate	gritty
8C	1.5	10	100% silt	black-grey	high	-
9A	1.0	1	60% sand 20% gravel 15% organic 5% brick	grey-brown	low	gritty
9B	2.0	5	90% silt 10% organic	black	high	gritty
9C	2.0	15	90% silt 10% sand	black	high	gritty

Table 5 Trace metal, PCB, oil and grease and loss on ignition of sediment samples collected from nearshore areas of the Lax Property by Booth Aquatic Research, December 17, 1985. All analysis are in mg/kg unless otherwise noted.

Station	Cadmium	Copper	Chromium	Zinc	Manganese	Nickel	Lead	Loss on ignition(%)	PCB	Oil&Grease
1A	16	82	150	5200	1580	20	945	4.42	0.22	7800
1B	4	122	142	1520	855	130	450	12.50	0.82	14000
2A	3	122	128	560	780	95	180	9.08	0.45	17000
2B	2	340	129	955	1270	400	360	12.43	0.25	6500
3A	10	160	240	2800	1280	180	655	1.34	0.60	11000
4A	2	34	114	360	775	20	56	1.60	<0.01	630
5A	4	30	148	1060	1260	30	260	2.30	0.07	530
6A	2	49	112	380	625	20	76	3.89	0.06	1800
7A	2	50	180	280	630	20	43	2.45	<0.01	230
8A	2	16	190	73	525	20	22	3.21	<0.01	190
9A	3	28	88	370	660	20	71	2.94	<0.01	440

Table 6 Trace metal concentration(mg/l) of water samples collected from nearshore areas of the Lax Property, December 18, 1985, by Booth Aquatic Research.

Station	Field pH	Cadmium	Copper	Chromium	Zinc	Manganese	Nickel	Lead
1	7.97	0.0	0.02	0.09	0.35	0.08	0.0	0.0
2	8.00	0.0	<0.01	0.08	0.02	0.03	0.0	0.0
3	8.08	0.0	<0.01	0.08	0.00	0.02	0.0	0.0
4	7.95	0.0	<0.01	0.07	0.04	0.03	0.0	0.0
5	7.86	0.0	<0.01	0.06	0.03	0.05	0.0	0.0
6	8.19	0.0	<0.01	0.07	<0.01	0.04	0.0	0.0
7†	8.17	-	-	-	-	-	-	-
8	8.03	0.0	0.00	0.08	0.02	0.07	0.0	0.0
9	8.01	0.0	<0.01	0.07	0.11	0.03	0.0	0.0
10	7.94	0.0	0.03	0.08	<0.01	0.04	0.0	0.0
11	7.93	0.0	0.02	0.06	<0.01	0.04	0.0	0.0
12	7.90	0.0	0.02	0.06	0.08	0.03	0.0	0.0
13	7.95	0.0	<0.01	0.06	0.03	0.04	0.0	0.0

Figure 1 . Surface soil samples collected by Ministry
of the Environment, Air Resources Branch, Phytotoxicology
Section, November, 1984.
Taken from Palmer, 1985.



Figure 2 Bore hole locations for samples collected by Hamilton-Wentworth Regional Laboratories, August, 1985. Taken from Forde, 1985.

2K

● Borehole

⊙ Borehole & Piezometer

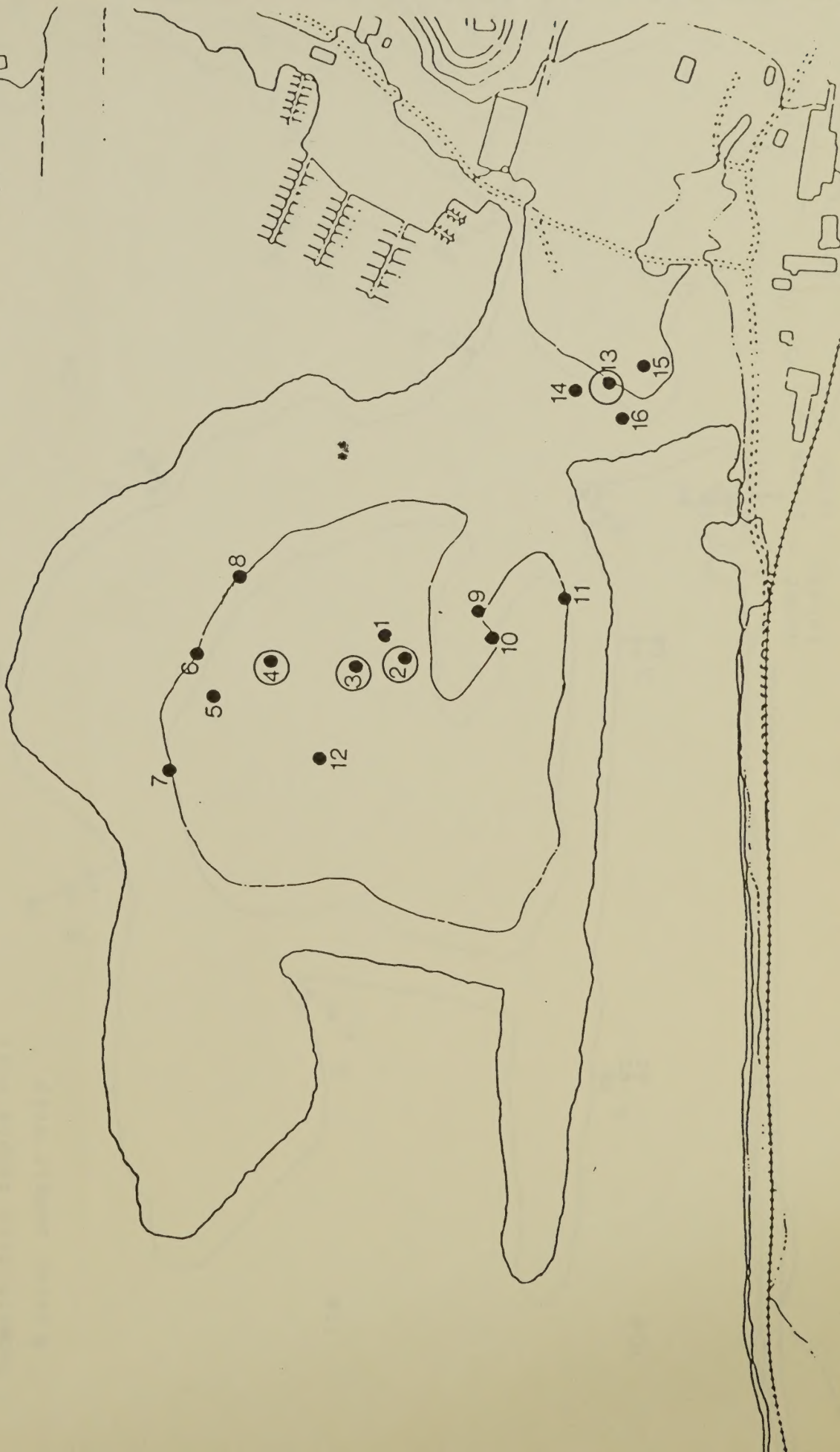
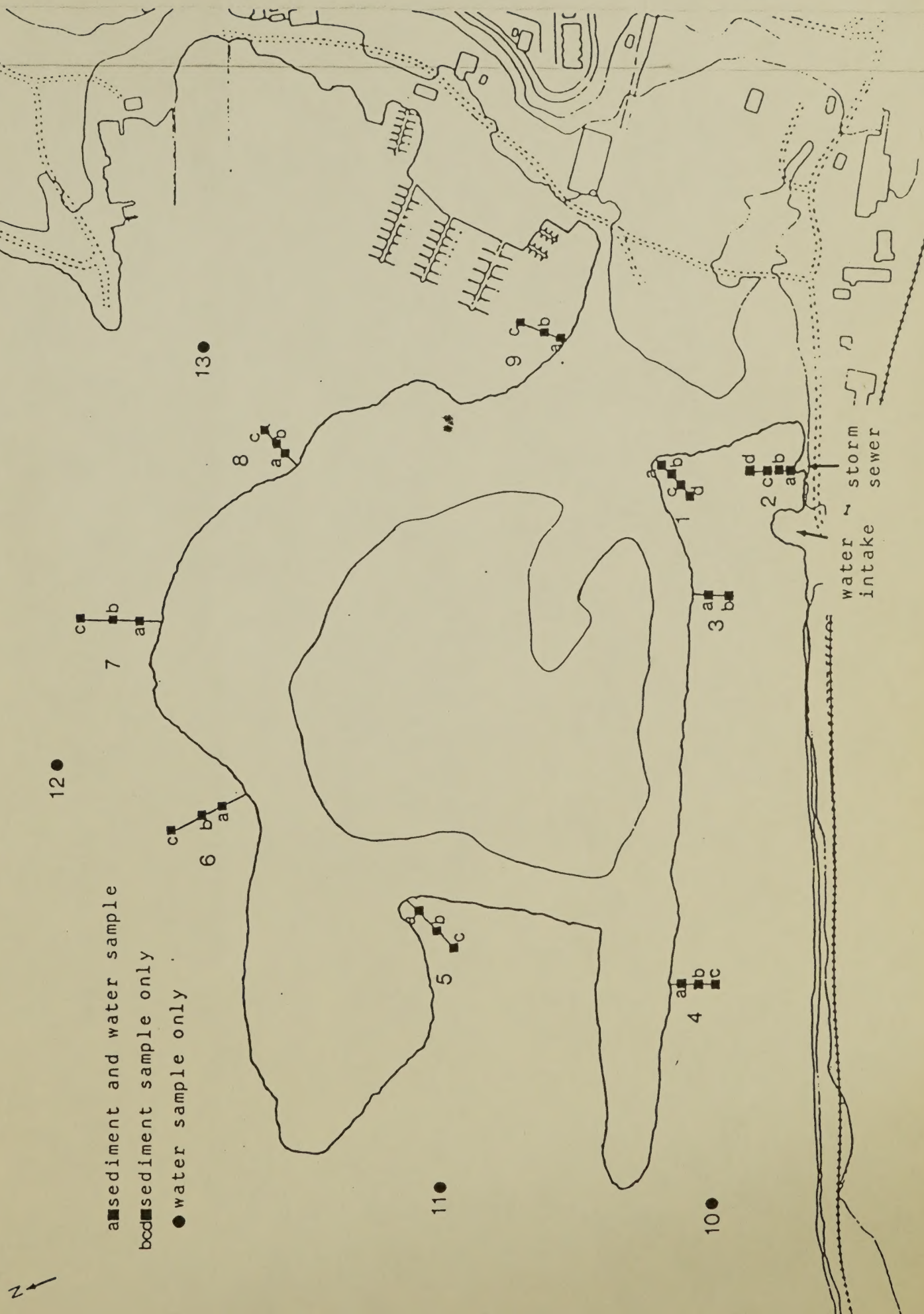


Figure 3 Sediment and water sampling locations in nearshore areas of the Lax Property.



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